Soil Changes Covered by Grass and Grazed by Cattle

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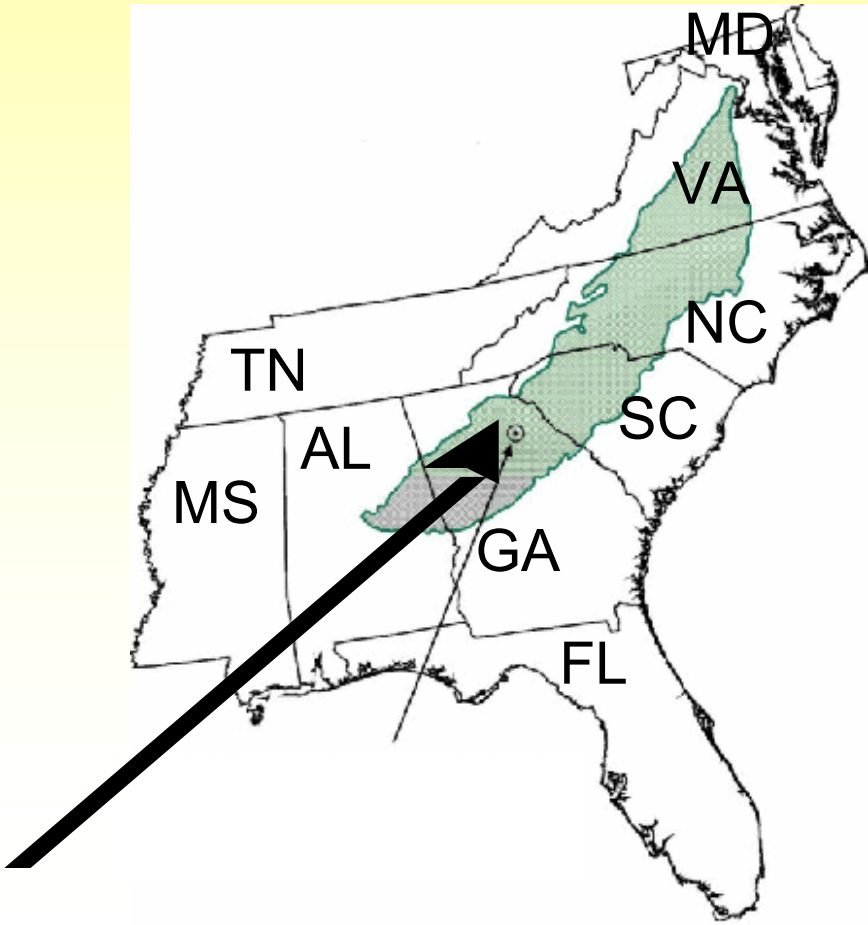
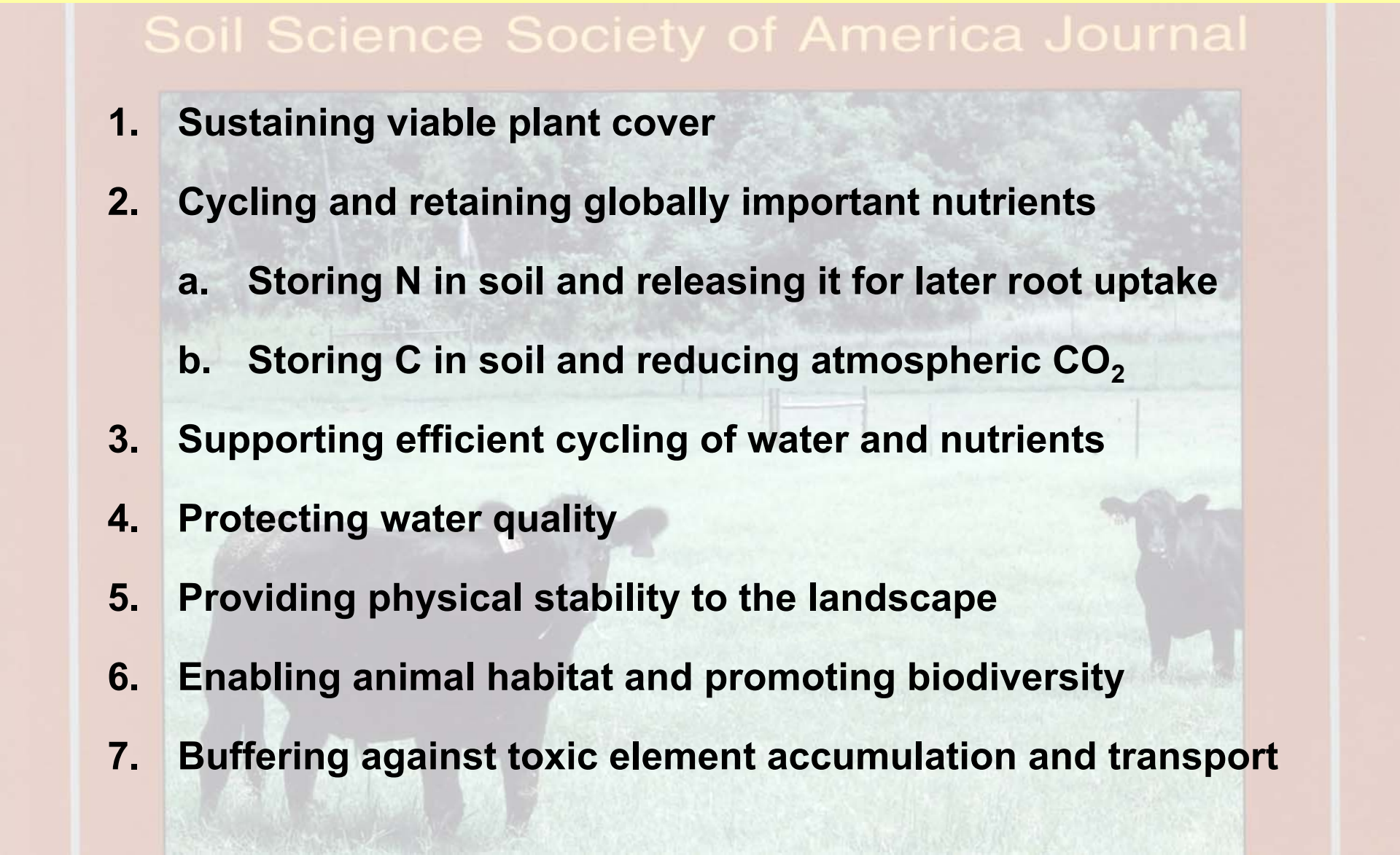


Soil Functions

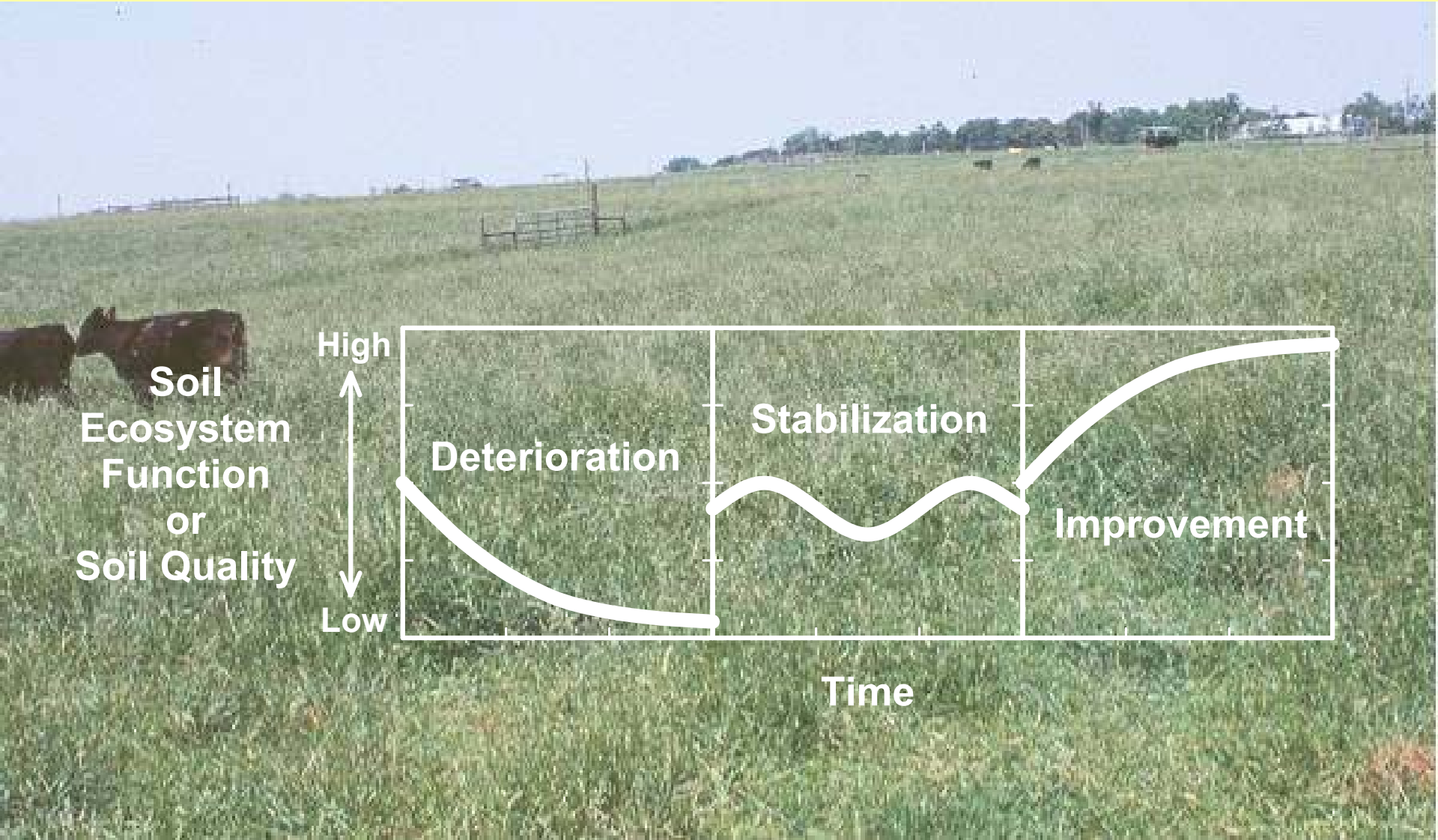
— *What are key functions altered by grass management?*



1. Sustaining viable plant cover
2. Cycling and retaining globally important nutrients
   a. Storing N in soil and releasing it for later root uptake
   b. Storing C in soil and reducing atmospheric CO_2
3. Supporting efficient cycling of water and nutrients
4. Protecting water quality
5. Providing physical stability to the landscape
6. Enabling animal habitat and promoting biodiversity
7. Buffering against toxic element accumulation and transport

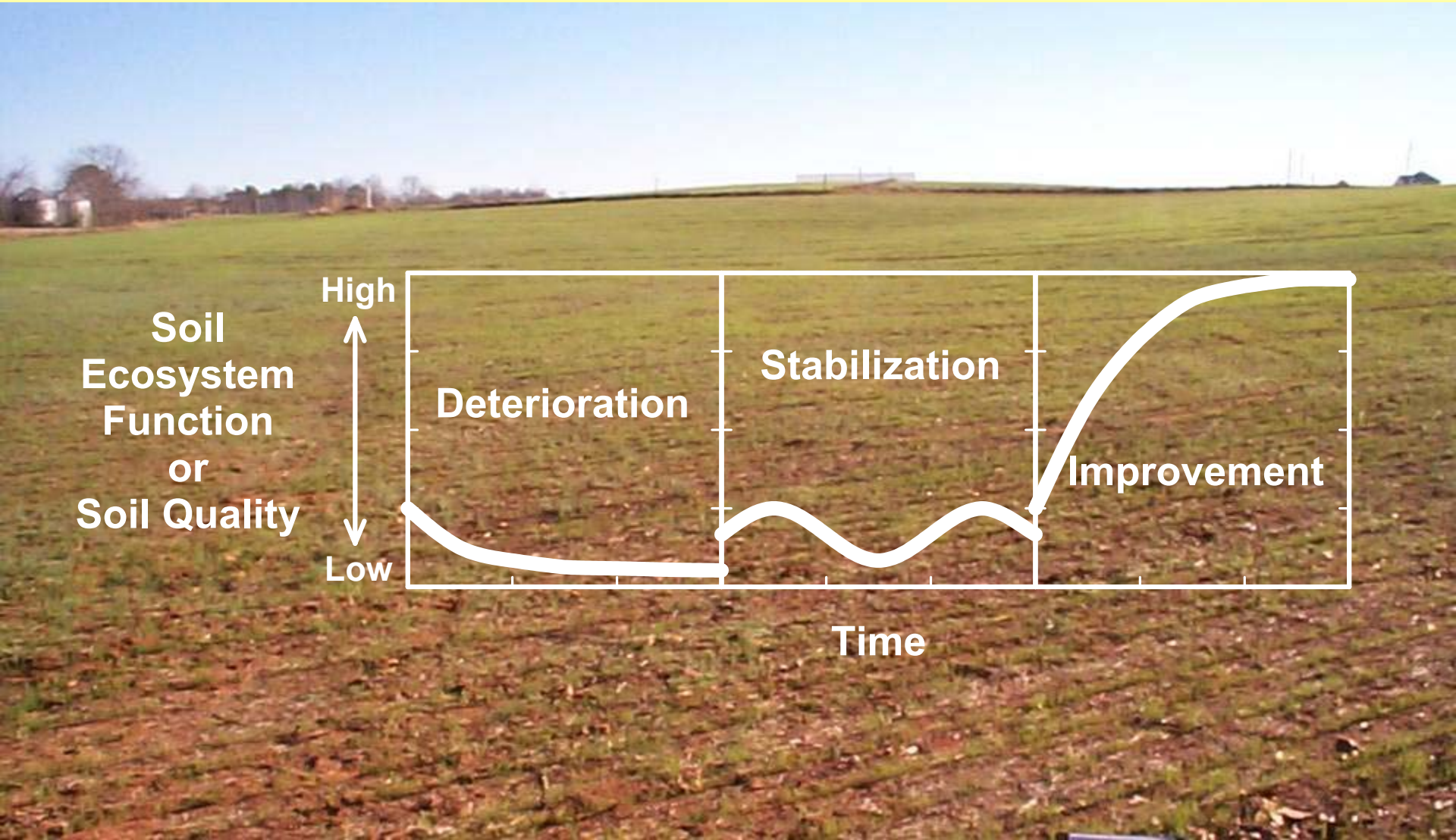
State of Grassland

— *Steady-state naturalized grassland?*



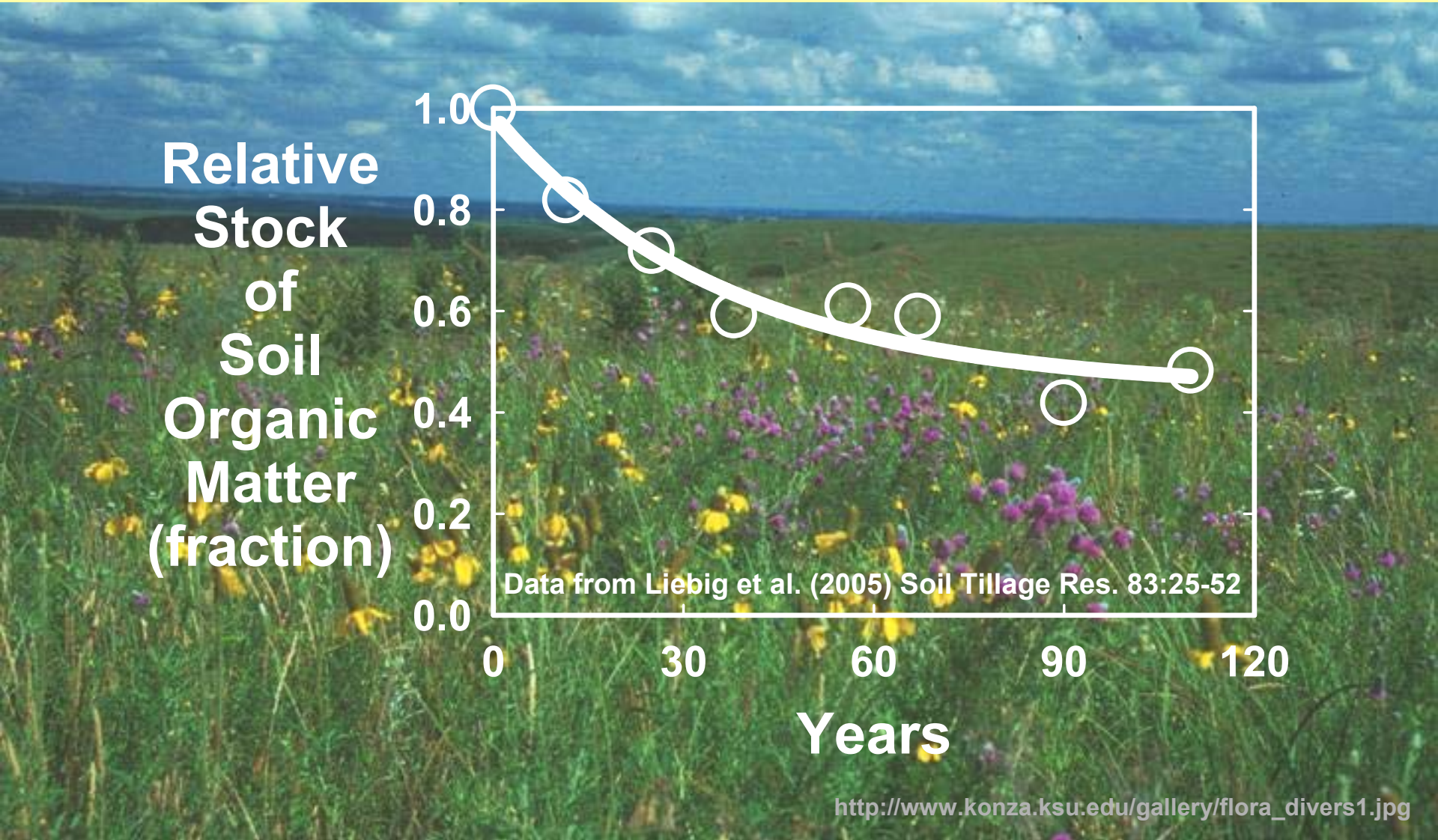
State of Grassland

— *Newly established grassland on previously degraded cropland?*



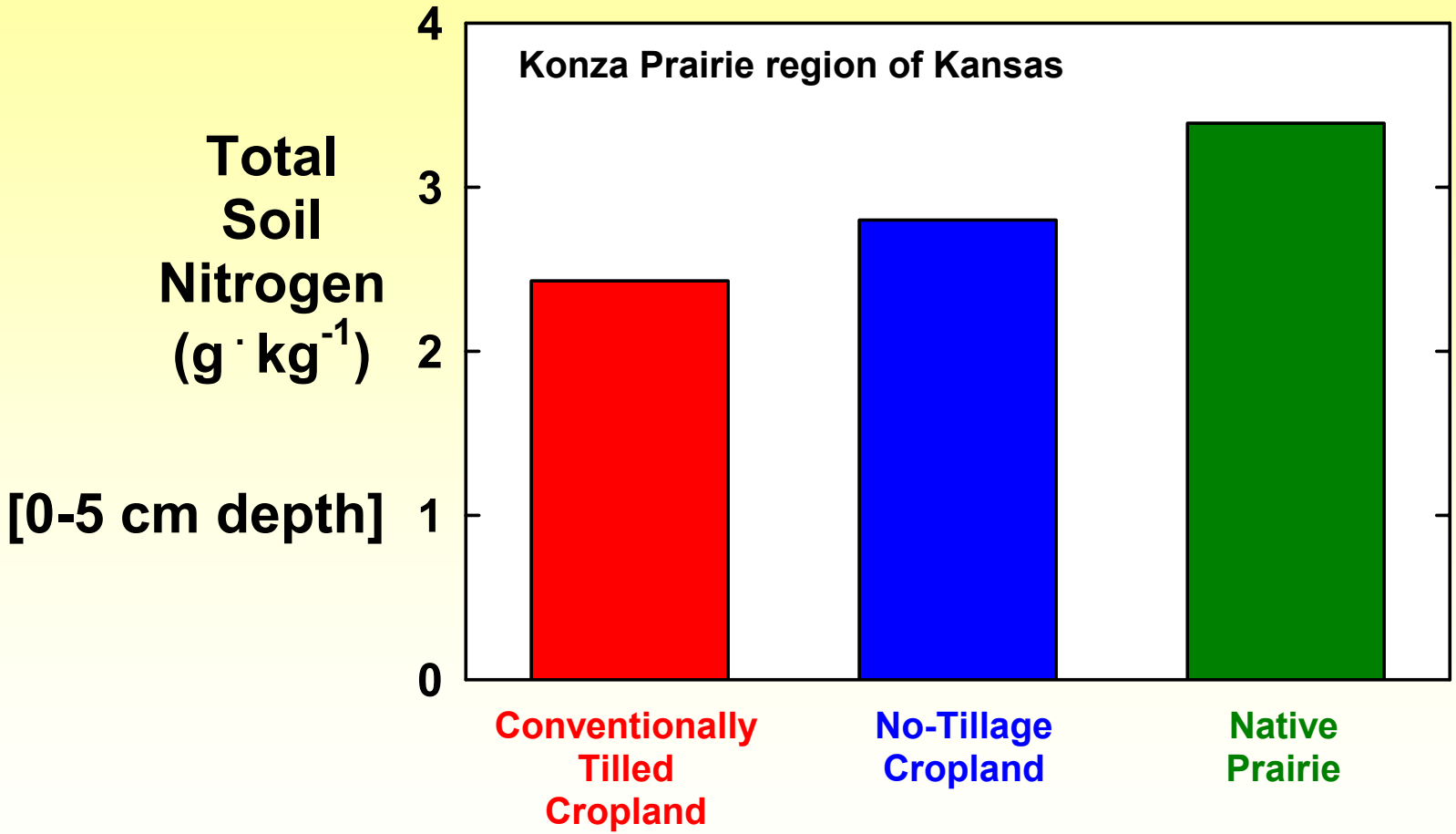
State of Grassland

— *Steady-state condition at ecosystem potential?*



Soil under Grass

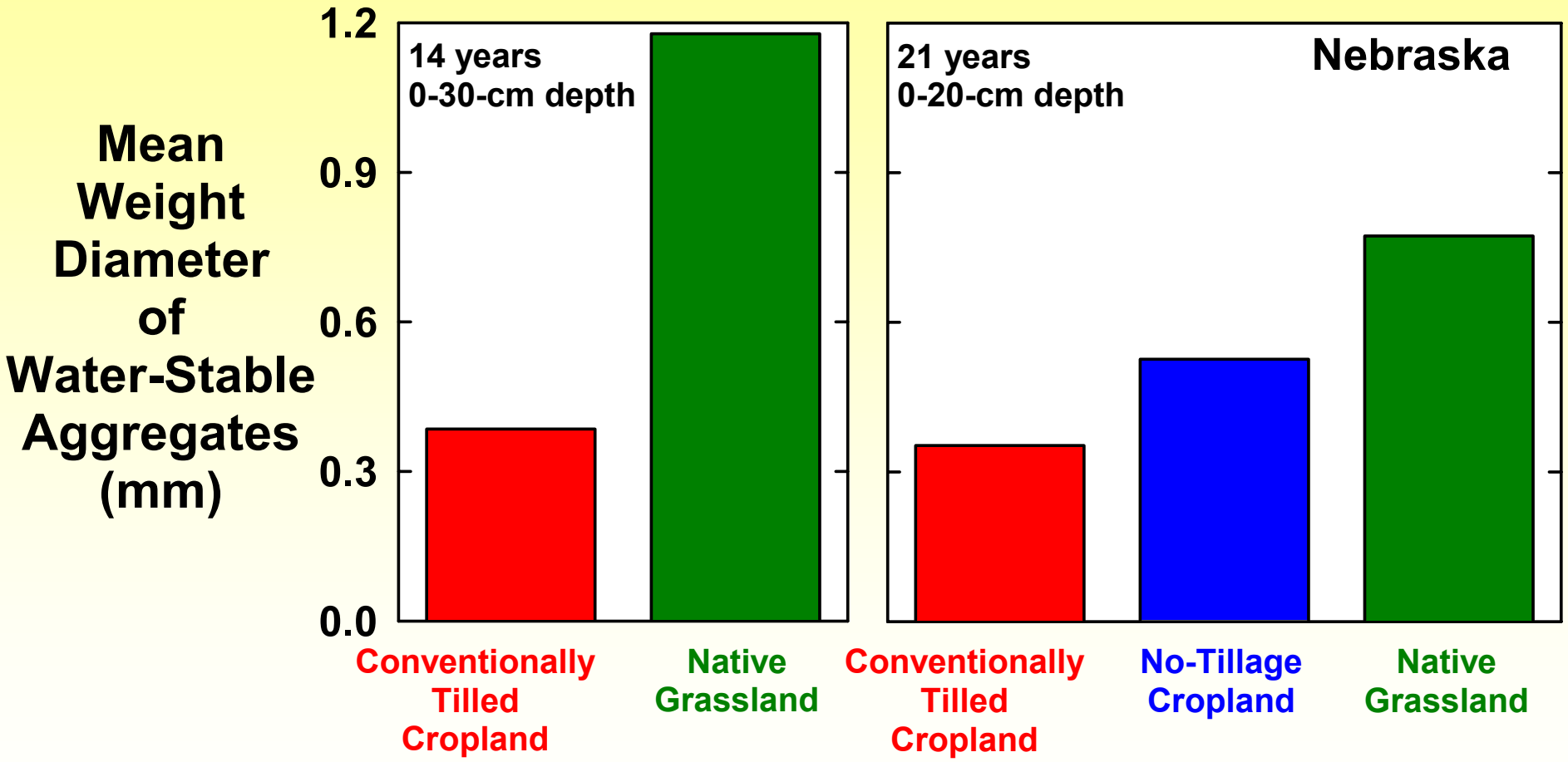
— *How does land use affect soil fertility?*



Data from Mikha and Rice (2004) Soil Sci. Soc. Am. J. 68:809-816
and Grahammer et al. (1991) Soil Biol. Biochem. 23:77-81

Soil under Grass

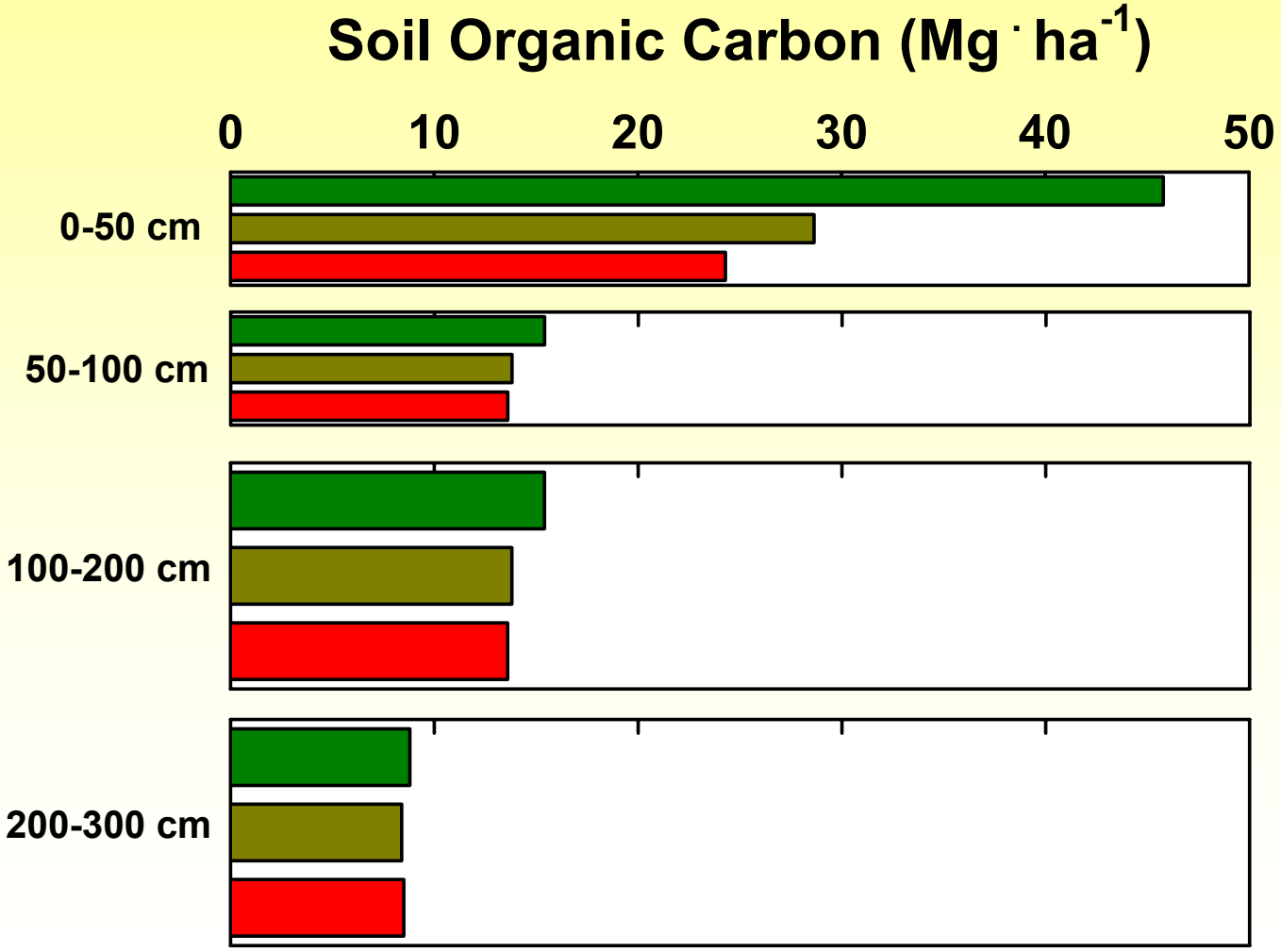
— *How does land use affect soil aggregation?*



Data from Cambardella and Elliott (1993) Soil Sci. Soc. Am. J. 57:1071-1076
and Elliott (1986) Soil Sci. Soc. Am. J. 50:627-633

Soil under Grass

— *How does land use affect soil-profile carbon storage?*



5 Locations in KS, NE, TX

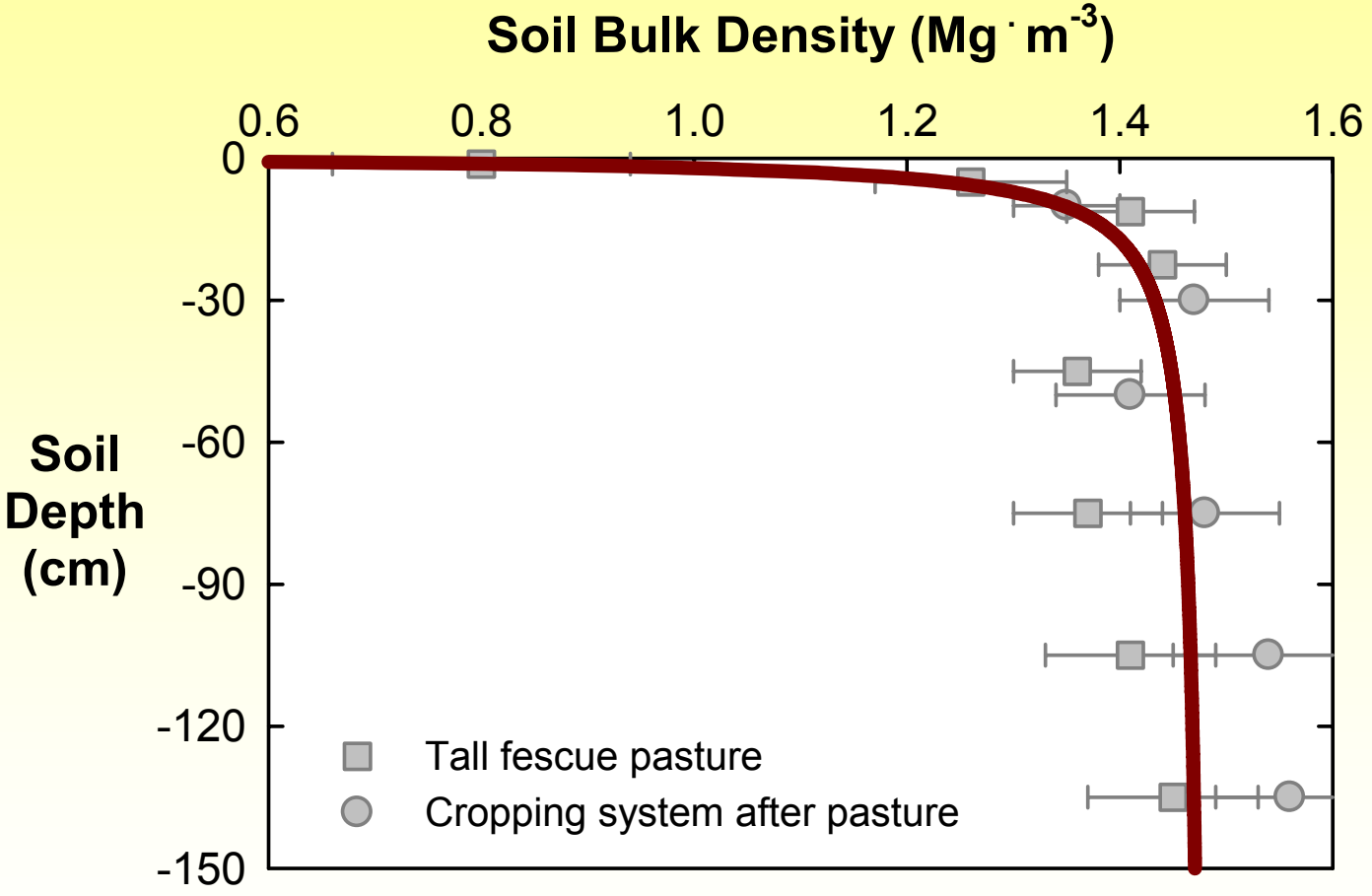
Native pasture
CRP (5-yr)
Cropland

Impact: Upper soil surface is the primary zone of change

Data from Gebhart et al. (1994) J. Soil Water Conserv. 49:488-492

Soil under Grass

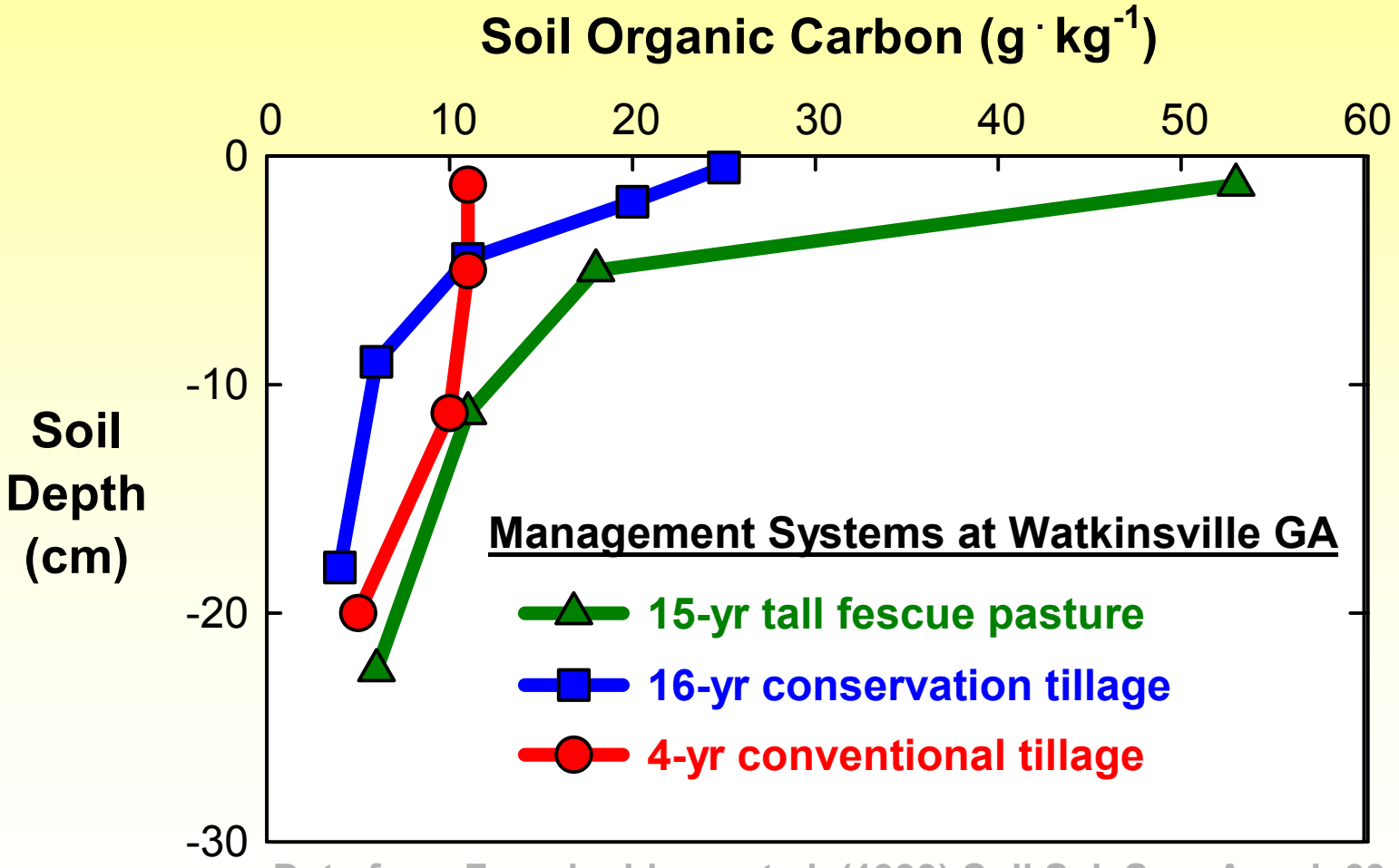
— *Is soil compacted under grass?*



Data from Franzluebbers and Stuedemann (2008) Soil Sci. Soc. Am. J. 72:613-625
and Franzluebbers et al. (2000) Soil Sci. Soc. Am. J. 64:635-639

Soil under Grass

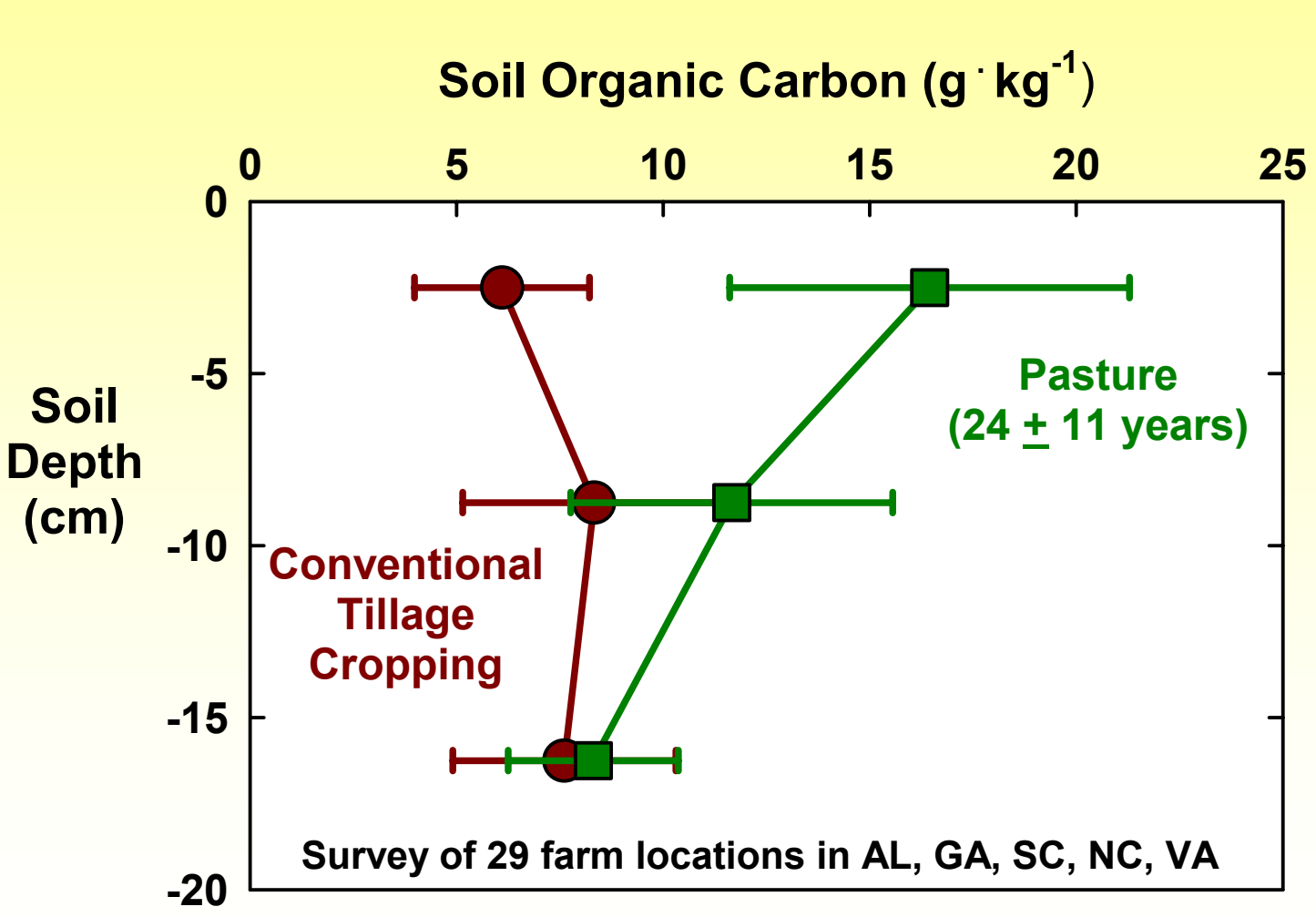
— *What are changes in near-surface soil organic C?*



Data from Franzluebbers et al. (1999) Soil Sci. Soc. Am. J. 63:349-355, Franzluebbers et al. (1999) Soil Sci. Soc. Am. J. 63:1687-1694, and Bruce and Langdale (1997) SOM in Temp. Agroecosyst., p. 247-261

Soil under Grass

— *Are these changes in near-surface soil organic C common?*



Sequestration of SOC (Mg ha^{-1} yr^{-1})

0.53 **

0.17 **

0.05 ns

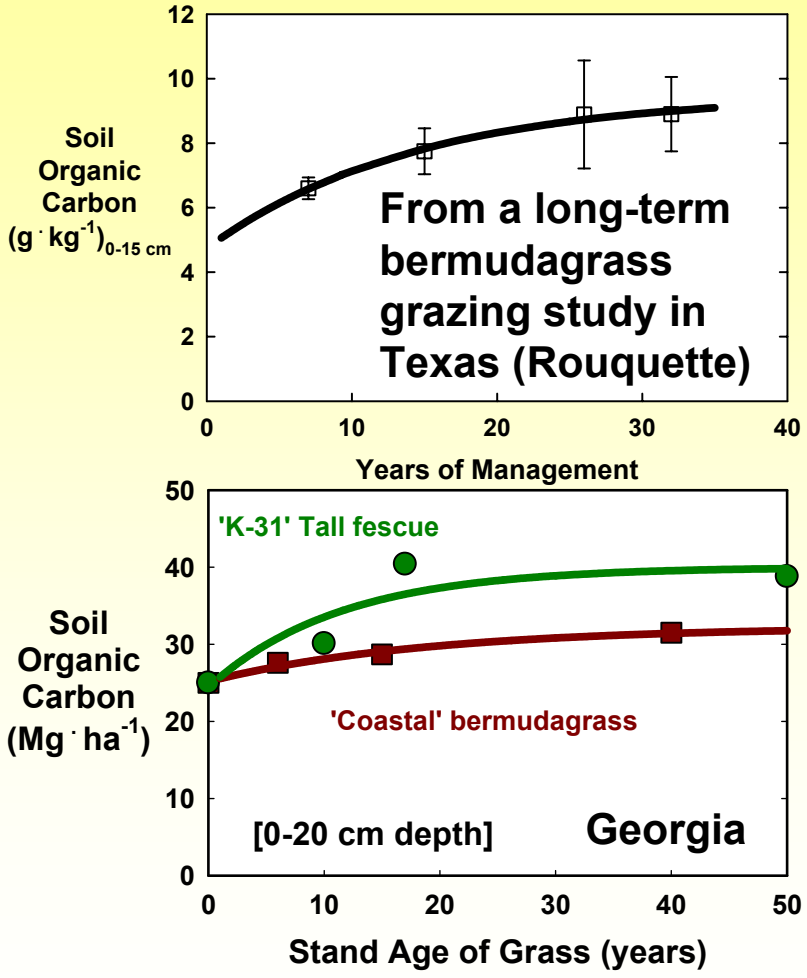
0-20 cm

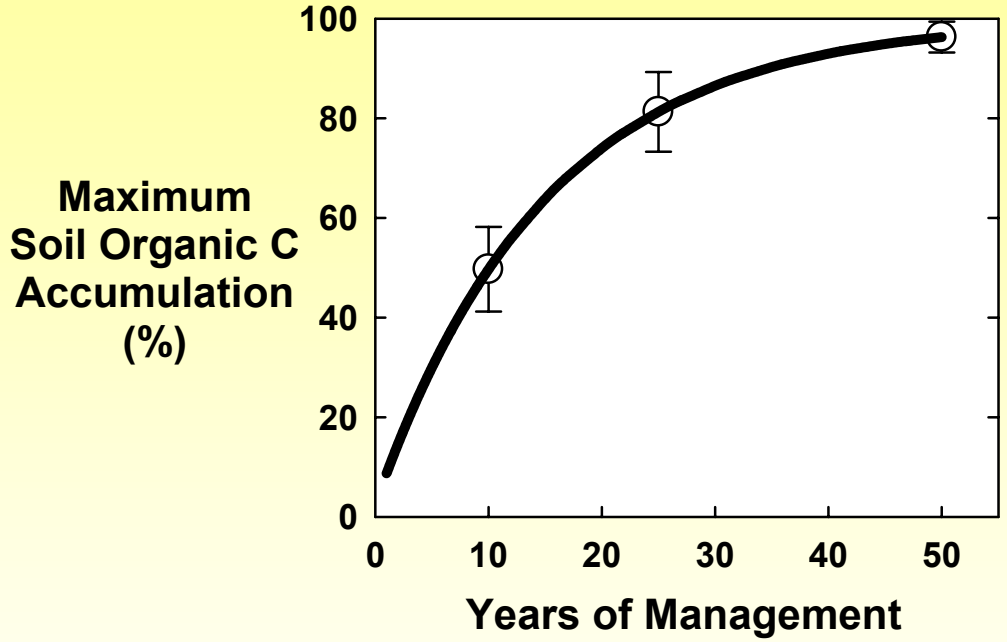
0.74 **

Data from Causarano et al. (2008) Soil Sci. Soc. Am. J. 72:221-230

Soil under Grass

— *What is the rate of soil organic C accumulation under grass?*





SOC (Mg ha^{-1} yr^{-1})	10 yrs	25 yrs	50 yrs
Hayed BG (GA)	0.29	0.21	0.13
Grazed BG (TX)	0.50	0.33	0.19
Grazed TF (GA)	0.91	0.55	0.31

Data from Wright et al. (2004) Soil Biol. Biochem. 36:1809-1816
and Franzluebbers et al. (2000) Soil Biol. Biochem. 32:469-478

Soil under Grass

— *What are some off-site impacts of grass management?*

Pennsylvania

Land use	Soil (g/kg – 0-5 cm depth)		Runoff loss (kg/ha)		
	Organic C	Mehlich-3 P	Sediment	Dissolved P	Total P
CT crop	13.7	0.32	767	0.02	0.52
NT crop	25.2	0.33	312	0.03	0.27
Grass	16.6	0.40	104	0.03	0.19

Oklahoma

Land use	Water runoff (mm/yr)	Runoff loss (kg/ha/yr)				
		Sediment	Nitrate N	Total N	Dissolved P	Total P
CT wheat	61	6515	1.3	15.0	0.2	2.8
NT wheat	111	625	1.4	7.2	0.7	1.4
Grass	48	100	0.1	1.2	0.1	0.1

Data from Sharpley and Kleinman (2003) J. Environ. Qual. 32:2172-2179
and Sharpley and Smith (1994) Soil Tillage Res. 30:33-48

Soil under Grazing

— *How do grazing animals affect surface soil?*

Depends on environment and how forage is managed…

Soil under Grazing

— *How extensive is compaction in grazed pastures?*

- ✓ **Poaching of soil with heavy animal traffic can damage forage and cause soil compaction leading to reduced infiltration, greater water runoff, and contamination of receiving water bodies with nutrients and fecal-borne pathogens**

- ✓ **In a review of grazing effects on bulk density** [Greenwood and McKenzie (2001) Aust. J. Exp. Agric. 41:1231-1250], **an increase in bulk density was observed with animal treading in most studies:**

  0.12 ± 0.12 Mg m^{-3} (n = 46)

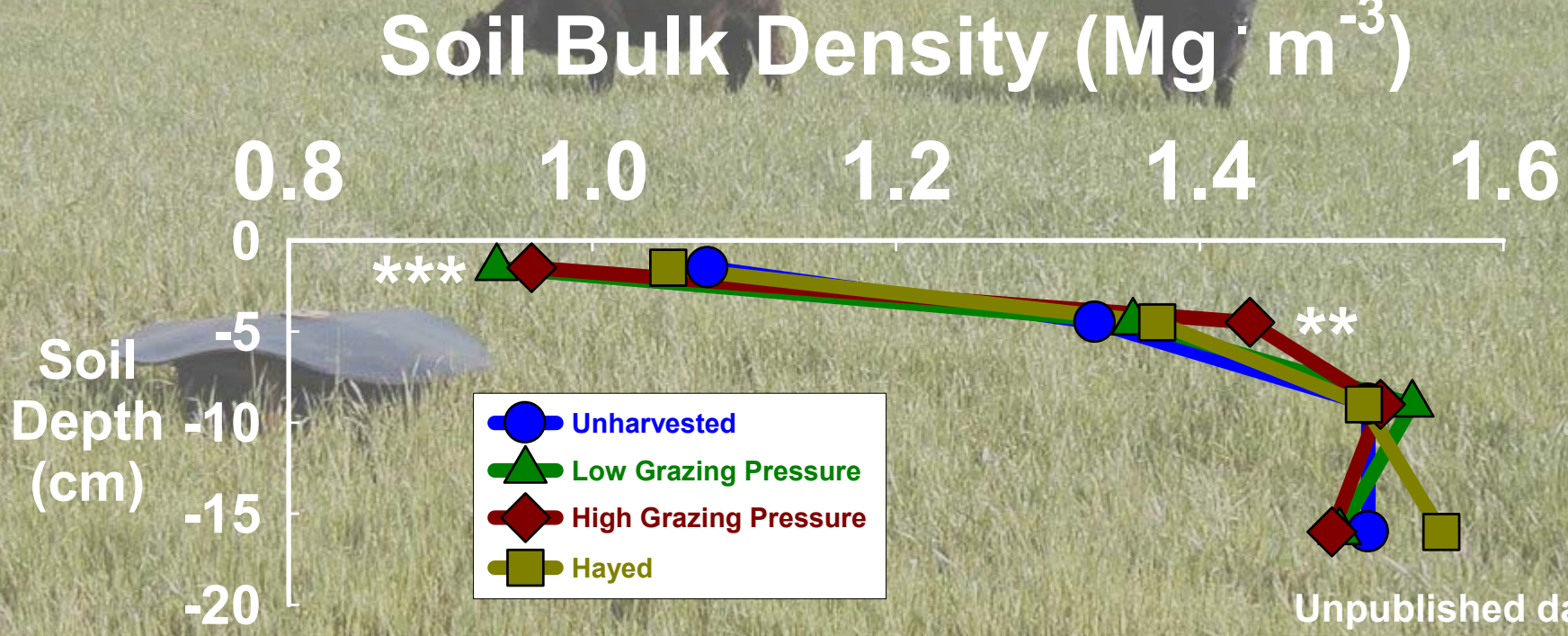
- ✓ **This situation represents an extreme treading condition, not what would be typical for judiciously managed pastures**

Soil under Grazing

— *Do cattle always compact soil?*

End of 12 years of bermudagrass / tall fescue management in Georgia

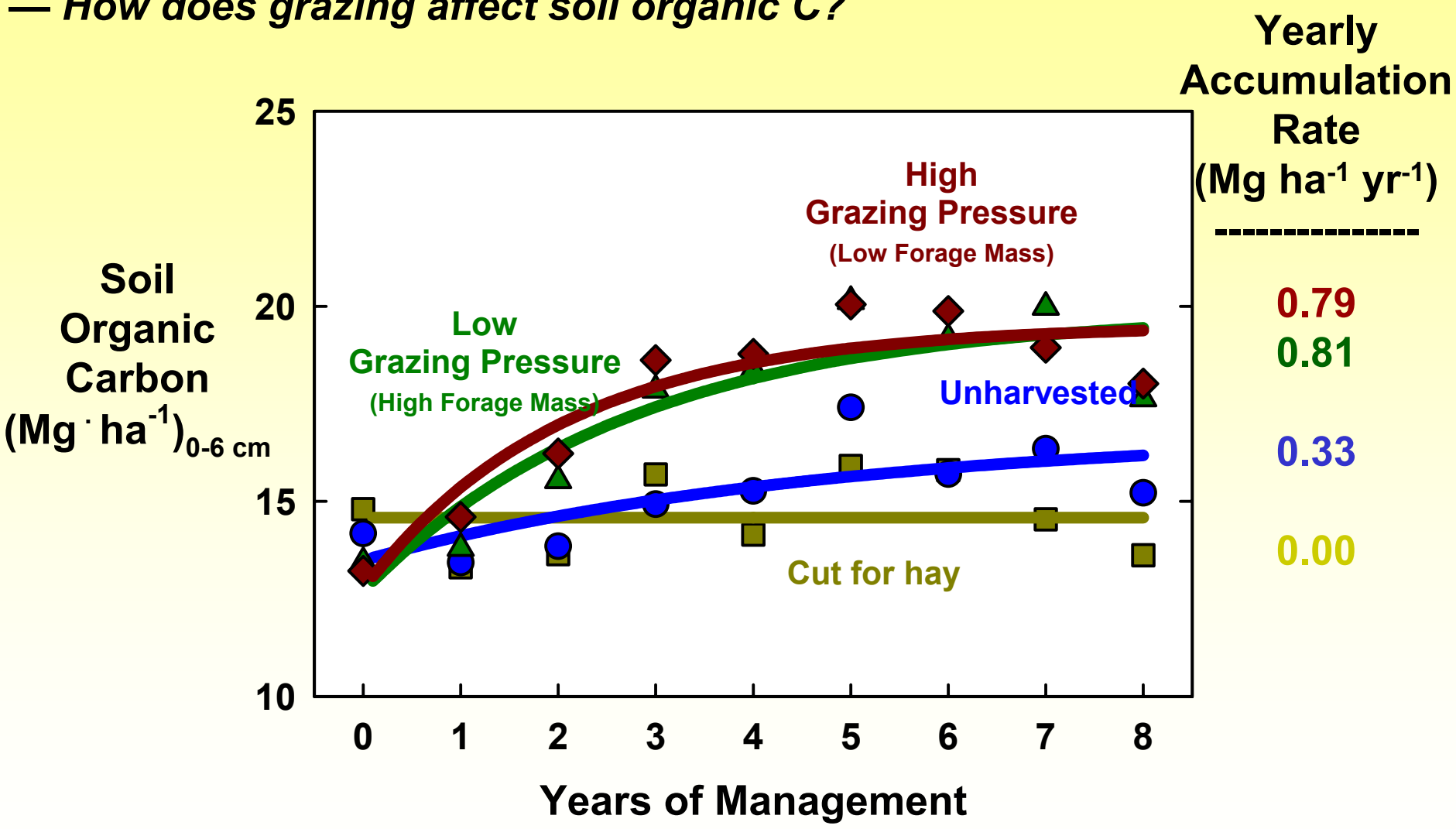
Soil Bulk Density ($Mg\ m^{-3}$)	Unharvested	Low Grazing Pressure	High Grazing Pressure	Hayed
0-20-cm depth	1.42	1.40	1.41	1.44



Unpublished data

Soil under Grazing

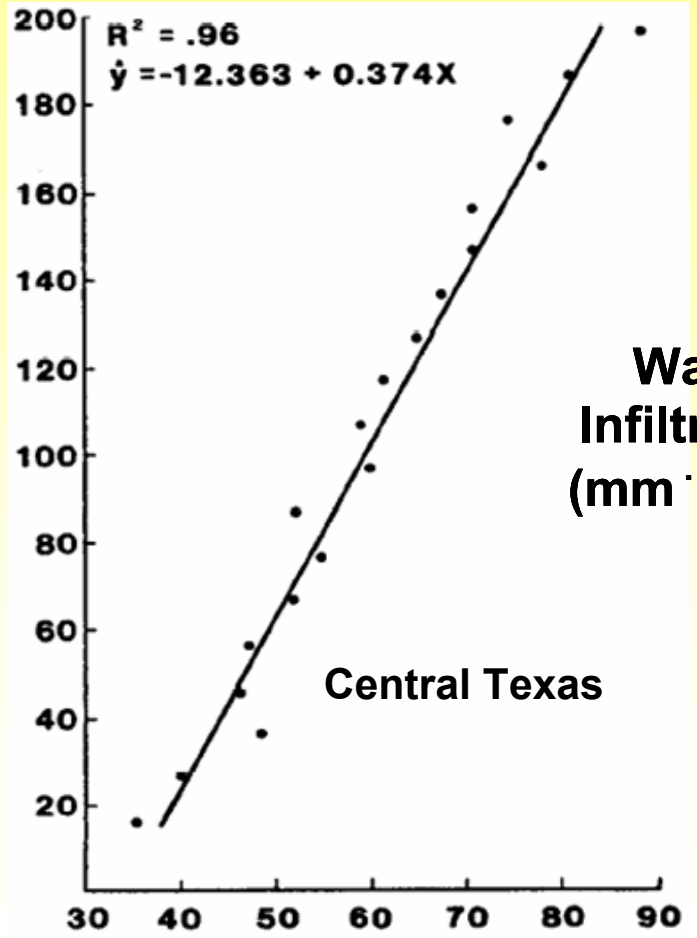
— *How does grazing affect soil organic C?*

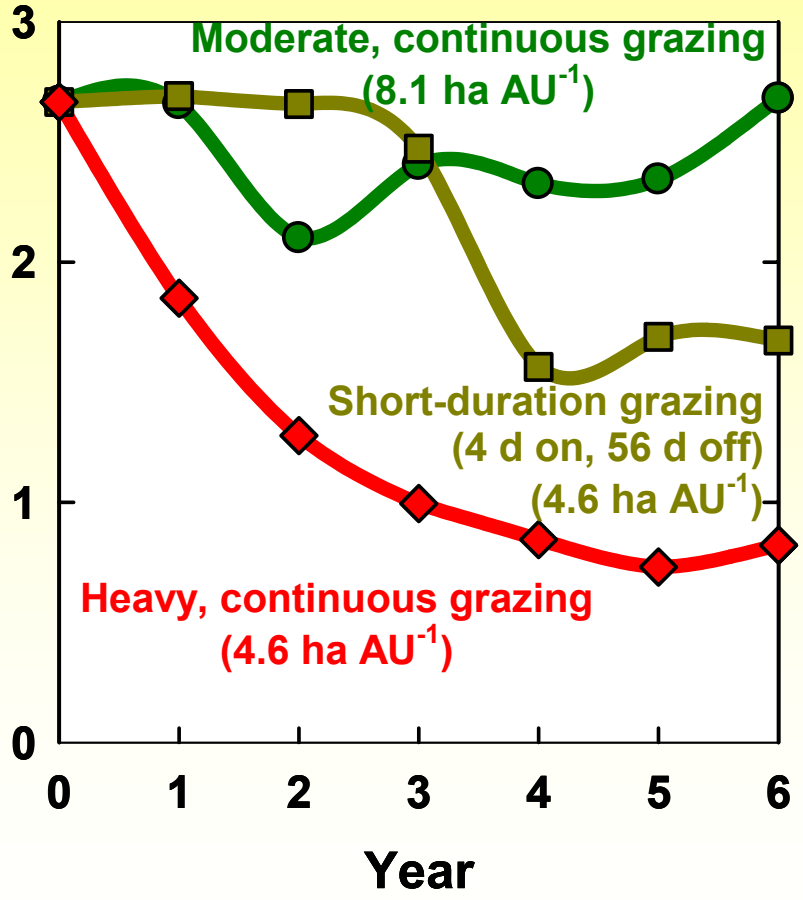


Data from Franzluebbers et al. (2001) Soil Sci. Soc. Am. J. 65:834-841 and unpublished data

Soil under Grazing

— *How does grazing affect water infiltration?*





Data from Thurow et al. (1988) J. Range Manage. 41:296-302

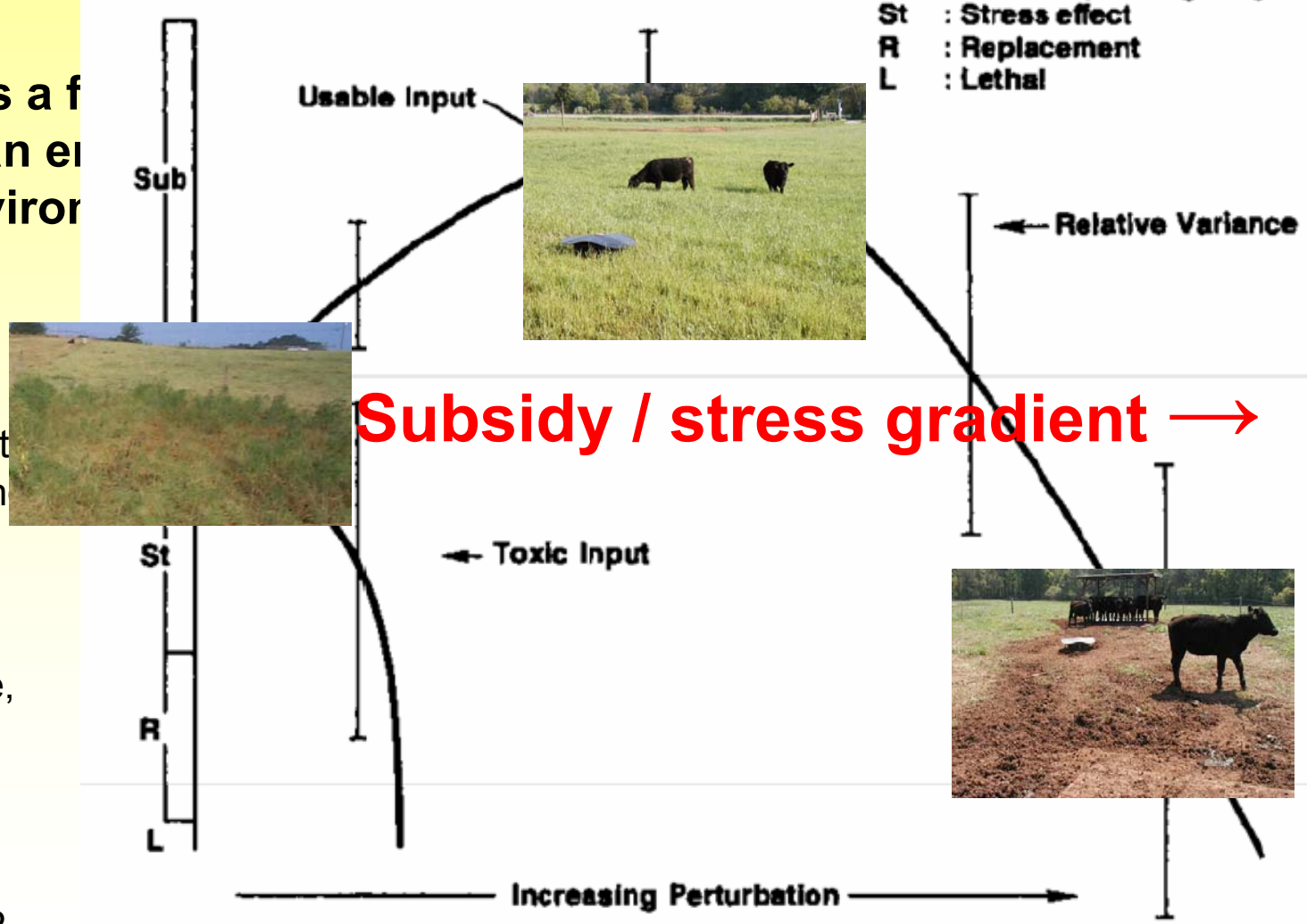
Soil under Grazing

— *How does grazing affect productivity?*

Management (as a f
perturbation) can e
degrade the enviro

Perturbations may be

- **energy** (harvest machine or grazin tillage inputs, chemical control, etc.)
- **C source** (type, frequency, placement, and quality of crop residues)
- **nutrients** (N, P, microelements, etc.)



From Odum et al. (1979) Bioscience 29:349-352

Summary and Conclusions

- ✓ **We can expect positive changes in soil aggregation, nutrients, and organic matter under grass-based systems**
  - **Extent dependent on environment and previous conditions of land**
- ✓ **Negative and positive changes in soil porosity, infiltration, and organic matter can occur with animal grazing**
  - **Dependent on the balance between carrying capacity and stocking density**